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Report

Challenges in converting an interviewer-administered food probe database to self-administration in the National Cancer Institute automated self-administered 24-hour recall (ASA24)

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ABSTRACT

The National Cancer Institute (NCI) is developing an automated, self-administered 24-hour dietary recall (ASA24) application to collect and code dietary intake data. The goal of the ASA24 development is to create a web-based dietary interview based on the US Department of Agriculture (USDA) Automated Multiple Pass Method (AMPM) instrument currently used in the National Health and Nutrition Examination Survey (NHANES). The ASA24 food list, detail probes, and portion probes were drawn from the AMPM instrument; portion-size pictures from Baylor College of Medicine's Food Intake Recording Software System (FIRSSt) were added; and the food code/portion code assignments were linked to the USDA Food and Nutrient Database for Dietary Studies (FNDDS). The requirements that the interview be self-administered and fully auto-coded presented several challenges as the AMPM probes and responses were linked with the FNDDS food codes and portion pictures. This linking was accomplished through a "food pathway," or the sequence of steps that leads from a respondent's initial food selection, through the AMPM probes and portion pictures, to the point at which a food code and gram weight portion size are assigned. The ASA24 interview database that accomplishes this contains more than 1100 food probes and more than 2 million food pathways and will include about 10,000 pictures of individual foods depicting up to 8 portion sizes per food. The ASA24 will make the administration of multiple days of recalls in large-scale studies economical and feasible.

1. Introduction

Although interviewer-administered 24-hour recalls (24HRs) are an important tool for assessing dietary intake in population studies, the expense involved in collecting and coding each recall has prohibited the use of this methodology for many large-scale dietary studies. A 24HR interview can take approximately 30–45 min to conduct and additional time to code (Thompson and Subar, 2008). Dietary interviewers must be highly trained and experienced to collect quality interviews that provide enough information for accurate coding. Similarly, dietary coders require extensive training in order to accurately code dietary recalls to provide nutrient consumption. As a single 24HR is not considered representative of an individual's usual diet, multiple 24HRs are desired for many studies of nutrient intake. These factors contribute to the desire to simplify the process of collecting 24HRs.

USDA is the leader in 24HR methodology, having used the 24HR interviews as the primary dietary assessment method in nationwide surveys of food consumption since 1965 (Raper et al., 2004). USDA developed the multiple pass method of conducting the 24HR interview, which relies on having the interviewer question the respondent about food intake using several "passes" or reviews of the day's intake. This method has been shown to improve the ability of respondents' recall of foods consumed (Conway et al., 2003). In 2001, USDA developed an automated 24HR tool called the Automated Multiple Pass Method (AMPM) where the computer presents questions for each food according to specifications established by USDA, thus providing standardization across interviewers (Raper et al., 2004). In addition, USDA also automated a process to assign FNDDS food codes to many of the pathways in

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the interview, which improved the consistency of the food coding process and decreased the coding time. Dietary coders still review each assigned food code, make corrections if needed, and assign food codes to any unmatched responses. The AMPM has been used since 2001 to collect What We Eat in America data in the National Health and Nutrition Examination Survey (WWEIA NHANES).

Although self-administered dietary interviews have been developed for the computer and the Internet (Kohlmeier et al., 2007), to date none have utilized the USDA AMPM as the source of the interview questions. In 2005, the National Cancer Institute (NCI) initiated a collaboration to develop an automated self-administered 24-hour recall (ASA24) that would employ computer technology to collect 24HRs through the Internet. The result of this collaboration is a computer-assisted 24HR that is fully auto-coded and linked to a comprehensive nutrient database. As in the AMPM interview, the ASA24 interview begins by asking the respondent to pick from a list of foods (called Food List Terms) the foods and beverages they consumed. After their list is complete, the ASA24 presents questions, referred to as probes, which the respondent must answer about each food. The resulting information (known as a "food pathway") provides enough information to assign a food code, portion size, and nutrient data, all of which are taken from USDA's Food and Nutrient Database for Dietary Studies (FNDDS). Respondents can use Baylor College of Medicine's photographs of varying quantities of the food as aids in answering the ASA24's portion-size questions. The ASA24 interview database contains all the foods, probes and responses, and portion photographs needed for the interview.

This paper describes the collaboration and process used to develop the ASA24 interview database and discusses the challenges encountered in converting an interviewer-administered instrument to a self-administered instrument and the methods by which those challenges were resolved.

2. Methods

2.1. Collaborators

The project team for the ASA24 was led by the NCI and included Archimage, a graphics design studio; Baylor College of Medicine; Westat, a contract researcher; and USDA's Center for Nutrition Policy and Promotion. Archimage was responsible for the design and development of the graphic user-interface of the ASA24; Baylor College of Medicine was responsible for providing food pictures and assisting in the instrument design; Westat designed, built and implemented the ASA24 interview database, conducted usability and cognitive testing of the software, and provided web services; and USDA's Center for Nutrition Policy and Promotion collaborated in the decisions made to adapt the AMPM to self-administration.

2.2. Resources for building the ASA24 interview database

2.2.1. AMPM Specifications Database

The USDA Agricultural Research Service (ARS) provided NCI with its AMPM Specifications Database. This database, which contains the food detail probes for the AMPM interview, was the starting point for creating the ASA24 interview database.

ARS also provided 3 years of frequency data (2002–2004) for each food probe and response in the AMPM interview from the WWEIA survey conducted in the NHANES (USDA, 2004b). The frequency data were used to streamline the ASA24 interview by eliminating food probes and responses that had never been used, and to ensure that frequently reported responses were included.

2.2.2. The Food and Nutrient Database for Dietary Studies (FNDDS)

FNDDS is a publicly available database of foods, their nutrient values, and the gram weights for volumes or other amounts of food that may be reported. Developed by USDA, this database is used to analyze data from WWEIA NHANES (USDA, 2004a). We linked the ASA24 interview probes to food codes in the FNDDS, version 1.0. Only those food codes that were actually used to code data in WWEIA NHANES and were not either baby foods (e.g. formula or jarred baby foods) or recipe ingredients (e.g. flour, spices) were used in the ASA24.

2.2.3. Food portion photographs

Food portion photographs are used as aids to help ASA24 respondents report the amount of each food consumed. Baylor College of Medicine initially provided more than 4000 food portion pictures, which they developed for the Food Intake Recording Software System (FIRSSt) (Baranowski et al., 2002). Since then, Baylor College of Medicine has provided approximately 4000 additional photographs. In addition, ARS provided a series of graphic images of mounds representing a range of measures (e.g. 1/4 cup, 1/2 cup, 1 cup) developed for the Food Model Booklet used to report portions in WWEIA NHANES (McBride, 2001). These images are used in the ASA24 for various portion sizes of foods for which photographs have not yet been taken. These will eventually be replaced by photographs of the actual foods.

2.2.4. MyPyramid Equivalents Database for USDA Survey Food Codes

The MyPyramid Equivalents Database (MPED) was developed by ARS to allow researchers to examine dietary recall data in terms of MyPyramid-defined food groups (Friday and Bowman, 2006). The MPED provides MyPyramid food group quantities for foods in FNDDS in terms of numbers of cup equivalents, ounce equivalents, teaspoon equivalents, or grams for each FNDDS food code.

2.3. The ASA24 interview database

The approach to building the ASA24 interview database was to follow the food pathways from each AMPM Food List Term, through its associated probes and responses, to a single FNDDS food code. The AMPM portion-size questions and the FNDDS portion-size codes (for gram weights of various amounts of food) were used to determine the portion probes and photographs presented in the ASA24. The food pathways were tailored to the existing FNDDS food codes, and only those food pathways that could result in food and portion-size codes were retained in the database. Food List Terms used to build a respondent's food list were developed for each food pathway in the ASA24 (Zimmerman et al., 2006).

3. Results and discussion

The ASA24 is the first system that allows collection and automatic coding of a 24HR recall data using a self-administered interview based on the AMPM. The two requirements for the ASA24 interview database—that it be self-administered and fully auto-coded—presented numerous challenges as we attempted to link the AMPM to the FNDDS. Westat nutritionists relied on interviewing and coding experience to resolve many of these challenges. Solutions were proposed and decided upon by Westat, NCI, and USDA's Center for Nutrition Policy and Promotion.

3.1. The challenges of self-administration

3.1.1. Create a user-friendly tool

A primary challenge in designing the ASA24 was how to make it user-friendly so that the respondents would be engaged and encouraged to complete the interview. Professional judgment has been demonstrated to be a valid resource for developing dietary questionnaires (Probst and Tapsell, 2007). The nutritionists who

developed the ASA24 had extensive experience in collecting and coding dietary intakes, and this experience was vital in developing Food List Terms that would be easily identifiable by respondents. Because people use different strategies to remember the foods they consumed, the ASA24 was designed to offer respondents the option of reporting their foods using a traditional type-the-word-in-a-box search approach or a browse-through-a-list-of-food-categories approach.

To make the Food List Terms easy to identify using the search approach, they were worded and punctuated in a carefully designed manner, based on the specifications of the ASA24 search engine and the way respondents tend to report foods. For example, many Food List Terms contain descriptive parenthetical information, such as "Bacon (beef)," "Bacon (pork)," and "Bacon (turkey)." Each search algorithm was designed to focus on the food (in this case, "Bacon") and ignore the descriptor (in this case, "beef" or "pork"). As a result, any search of "Bacon" returns a list of items that starts with all the types of bacon (e.g. "Bacon (beef)," "Bacon (pork)") grouped together. Other foods containing bacon follow afterwards. This strategy not only ensures a logical list of food terms from a search query, it also simplifies the selection process for the respondent. If we had chosen to word Food List Terms with the descriptive information first (e.g. "Pork bacon"), the results of a search for "Bacon" would have interspersed types of bacon with other bacon-containing items, such as "Bacon, Egg, and Cheese Biscuit," "Sourdough Bacon Cheeseburger," and "Burger King Double Cheeseburger with Bacon." In contrast to the approach with bacon, Food List Terms for types of crackers such as "Animal cracker," "Goldfish cracker," and "Saltine cracker" do not place the descriptive information inside parentheses. Respondents frequently report crackers by including the brand name or type of cracker, but even if a respondent searched for the term "cracker," only cracker Food List Terms would be returned by the search engine, as the word "cracker" is not part of other common foods. This customization of the Food List Terms to the search engine enhanced the ability of respondents to quickly locate their foods.

To create a user-friendly browse approach for respondents who do not type or are not sure what terms to search on, the Food List Terms were sorted into 24 main food groups and split into 243 subgroups. The main food groups are intentionally broad (e.g. "Beverages," "Meats," "Vegetables") to help respondents locate the correct subgroup more easily. For example, "Beef" and "Hamburger" are 2 of 16 subgroups under the main food group "Meats." Opening a subgroup leads respondents to the Food List Terms.

3.1.2. Reduce food probes

Self-administered questionnaires must be designed to capture high-quality data as efficiently as possible. In the AMPM, the interviewer can choose a very general food term ("Milk") or a more specific one ("Skim milk"), depending on how the respondent reports foods consumed. However, a general food term requires the interviewer to ask a number of probes to obtain the information necessary to accurately code the food. For the ASA24, the food list was designed to include more descriptive detail, thus eliminating the number of probes needed to assign a food code. As mentioned above, the food list does not include the general name "cracker," because it would require a food probe to identify the type of cracker. Instead the food list contains the Food List Terms "Animal cracker," "Cheese cracker," and "Goldfish cracker." This not only makes the interview more efficient, it also trains respondents to seek detailed information about their foods when reporting their food list.

3.1.3. Direct respondents to select specific food pathways

Without an interviewer guiding respondents through the probes, the ASA24 had to be designed to make sure respondents answered probes appropriate for their food. The specificity in the Food List Terms is intended to trigger the software to initiate the correct food pathway for that food. For example, the food list does not include the Food List Term "Hamburger" because it lacks specificity as to whether it is a hamburger patty or a hamburger sandwich, each of which require different food pathways to get to a food code. So, instead of "Hamburger," the food list offers the Food List Terms "Hamburger on bread or bun," and "Hamburger patty." Selecting "Hamburger patty" takes the respondent through a probe about the leanness of the beef, while selecting "Hamburger on bread or bun" includes additional probes about bun, spread, vegetables, cheese, and other ingredients.

3.2. The challenges of auto-coding

3.2.1. Assign food codes to all Food List Terms

The requirement that every Food List Term in the ASA24 must result in an existing food code required a thorough review of each food pathway in the AMPM. If no food code could be assigned at the end of a food pathway, the path was eliminated. For example, FNDDS has food codes for cooked artichokes only, while the AMPM interview offers the option of reporting raw, creamed, or pickled artichokes as well. Because FNDDS food codes do not include raw, creamed, or pickled artichokes, the ASA24 interview does not ask the respondent how the artichokes were prepared.

In addition to AMPM paths that cannot be linked to an FNDDS food code, AMPM paths sometimes match multiple FNDDS food codes. For example, in the AMPM category for Cake, there are probes that ask flavor, icing, nuts, and whether the cake was homemade, purchased from a bakery, commercially prepared, or from a mix. If "from a mix," the FNDDS includes food codes for both standard cake mix and pudding-type cake mix, but the AMPM does not ask whether the cake was made using a standard mix or a pudding-type mix. Therefore, for the ASA24 the food code that was reported most frequently in WWEIA NHANES was selected.

Some AMPM categories were not used in the ASA24, resulting in the omission of some FNDDS food codes. Since the ASA24 is intended for use with adults, the AMPM categories for baby foods were not included. Although there are AMPM categories for frozen meals and Lunchables, foods that are components of these items are usually probed as individual foods in WWEIA NHANES. As extensive market checks of brand names and package weights would be required to add these items to the ASA24 food list, these categories were not added to this version of the ASA24 but may be considered for a future version. There are also some FNDDS food codes that cannot be linked to a path in the AMPM.

The AMPM and ASA24 handle certain foods such as sandwiches, green salads, and sundaes by reporting components of the food. For example, a tossed salad would be reported by listing the lettuce, tomatoes, carrots, and salad dressing in the salad; a food code is assigned to each component, resulting in multiple food codes being used for a single green salad. Since FNDDS also contains food codes for assembled sandwiches, salads, and sundaes, these food codes are not used in the ASA24.

After meeting all the requirements of auto-coding, the resulting ASA24 database uses 4249 of the 6974 FNDDS food codes. Of the 2725 food codes not used in the ASA24, 2018 (74%) had 0 mentions in WWEIA NHANES. Over half (360) of the remaining unused food codes had no pathway in the AMPM or were for baby foods or frozen meals. A quarter of the unused food codes were for items where more than 1 food code matched a single path, and the remaining unused food codes were for items like sandwiches, salads, and sundaes.

3.2.2. Determine portion sizes for each food code

The ASA24 uses photographs and images to help respondents report the amount of each food they consume. For most foods,

respondents are shown photographs representing 8 different portion sizes. It was a challenge to replicate the AMPM portion-size options because that system is designed to allow respondents to report the amount they consumed in almost any unit, while the ASA24 limited possible portion-size options to those available in each FNDDS food code.

Establishing procedures for converting the dimensions of food items to set portion sizes and standardizing the reporting of cooked meats was particularly difficult. For portions reported as dimensions in the AMPM, photographs of "small," "medium," and "large" sizes were created for the ASA24. These sizes were determined in one of two ways: if the food code included a default size for one piece of the specified food, that piece was defined to be the "medium" size piece; small was defined as one-half the size of the medium and large was defined as 1.5 times the medium, following ARS coding guidelines. Alternatively, for some foods, the 25th, 50th, and 75th percentile of the gram weight consumed as reported in NHANES (2001–2004) was used to determine the small, medium, and large size piece, respectively. The method selected depended on whether: (i) the gram weight from NHANES represented one piece of the food; (ii) the pieces created from the percentiles could be obtained and photographed; and (iii) default sizes were available in the food code.

For meats, an additional challenge was to match the cooked weight yield to the description in the FNDDS food codes. To overcome this, meats were purchased to match the raw weight item as defined in the FNDDS, and then cooked and photographed, regardless of the yield. For example, for pork chops, a portion code is "Pork chop: 1 medium (5.5 oz, with bone, raw, yield after cooking, bone removed), weight = 87 g." The photograph of this food is a bone-in cooked pork chop which weighed 5.5 ounces when raw.

In addition to determining how to present portion photographs, the range of portion photographs to present needed to be established. Data from both WWEIA NHANES and FNDDS were consulted to determine the range of portions to be displayed. The data from WWEIA NHANES provided information on percentiles of intake for foods; FNDDS has a default weight for every food code, the Quantity Not Specified amount, which is coded for intakes when the respondent reports "Don't know" for the amount eaten. This Quantity Not Specified amount is determined by USDA to be the most common amount consumed for a particular food. Since a major concern with dietary recalls is underreporting (Jonnalagadda et al., 2000), a general guideline was established that the largest portion displayed would be approximately 3 times the Quantity Not Specified amount from FNDDS. WWEIA NHANES percentiles of intake were also checked to ensure that the maximum portion would encompass the 95th percentile of intake reported.

4. Conclusion

The ASA24 interview database organizes almost 7000 Food List Terms into 24 food groups and 243 food subgroups. Over 1100 different probes collect details about the foods. The ASA24 currently has 4400 photographs to represent portions in the ASA24, and this number is expected to increase to about 10,000 for the first release. ASA24 output data will include individual level nutrient and pyramid food group estimates based on FNDDS. The goal of the ASA24's developers is to provide researchers with the ability to economically and feasibly collect multiple 24HRs in large-scale studies.

The ASA24 database will require project collaborators to maintain and update food pathways as new versions of the FNDDS or MPED are released, changes are made to the AMPM, and photographs are added. As the ASA24 is used by various researchers, the opportunity to assess and refine the Food List Terms and the portion-size photographs will serve to further enhance the ASA24 interview. ASA24 is expected to be available for use by researchers in the spring of 2009 (NCI, 2008). Current information about the ASA24 may be found at http://riskfactor.cancer.gov/tools/instruments/asa24.html.

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